MODILEWSKI[16] has also described a 16-nucleate embryo sac in *Gunnera chilensis*, in which case the four megaspores, not separated by walls, all take part in forming the embryo sac. Although no definite proof was obtained, he believed the embryos to be parthenogenetic.

An interesting embryo sac is described by DESSIATOFF,[17] who finds 16 nuclei in *Euphorbia virgata* at the fertilization period. The 16 nuclei come from one megaspore, and consequently the situation is somewhat different from that found in *Peperomia*, where 4 megaspores enter into the formation of the sac. The 16 nuclei are arranged in four groups of four each, and one nucleus from each group moves to the center of the sac, where the four fuse to form the endosperm nucleus. There are three antipodals, and an egg apparatus of two synergids, and an egg. The two other groups remain at the side of the sac and resemble the egg apparatus. In general, this embryo sac resembles that of the Penaeaceae as described by Miss STEPHENS.—CHARLES J. CHAMBERLAIN.

The sperm nuclei of Lilium.—Since zoological literature furnishes no instance of the fertilization of the egg by a naked male nucleus unaccompanied by any cytoplasm, and since the male nucleus in plants has in nearly all cases been shown to be accompanied by cytoplasm, definite proof of fertilization by a naked nucleus is worth recording, especially since the nucleus is regarded by many as the sole bearer of hereditary qualities. Both STRASBURGER and KOERNICKE have claimed that in *Lilium* the sperm nucleus, at the time of fertilization, is not accompanied by any cytoplasm. A paper by NAWASCHIN,[18] the discoverer of double fertilization, gives a very complete account of the generative cell and development of the sperm nuclei in the classic *Lilium Martagon*. The excellent technic, remarkably close series of stages, and the carefully drawn illustrations, all support NAWASCHIN'S description and conclusions. The cytoplasm of the generative cell has a finely granular structure up to the anaphase of the division of its nucleus, at which time its cytoplasm begins to mingle with the general cytoplasm of the pollen tube. The mitosis which gives rise to the two male nuclei is characterized at every stage by sharply differentiated chromosomes, so that the sperm nuclei do not reach the resting stage, but remain in the condition characteristic of telophase. Consequently, it is not improbable that the mature nuclei are capable of movement. The achromatic spindle is scanty and in some cases doubtful, and in others cannot be identified at all, so that it is probable that

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[16] MODILEWSKI, J., Zur Embryobildung von *Gunnera chilensis*. Ber. Deutsch. Bot. Gesell. **26a:**550–556. *pl. 11*. 1908.

[17] DESSIATOFF, N., Zur Entwickelung des Embryosackes von *Euphorbia virgata*. Ber. Deutsch. Bot. Gesell. **29:**33–39. *figs. 17*. 1911.

[18] NAWASCHIN, SERGIUS, Näheres über die Bildung der Spermakerne bei *Lilium Martagon*. Ann. Jard. Bot. Buitenzorg. II. Supplement III. 871–904. *pls. 33, 34*. 1910.

the chromosomes in this mitosis move independently of any spindle.—C. J. CHAMBERLAIN.

Studies in ferns.—Apogamy in *Cystopteris fragilis*, hybridization in *Asplenium*, and conditions of heredity in certain ferns, have been investigated by A. HEILBRONN.[19] The group last considered includes, as true varieties, the following: *Aspidium Filix-mas* var. *grandiceps*, *A. aculeatum* var. *cruciato-polydactylum*, *Athyrium Filix-femina* var. *corymbiferum*, *A. Filix-femina* var. *multifidum*, *A. Filix-femina* f. *multifidum Mapple-Beckii*, *A. Filix-femina* var. *laciniatum* and var. *purpureum* Lowe. Others not considered true varieties are *Athyrium Filix-femina* var. *Fieldiae* Moore, *A. Filix-femina* f. *multifidum minus*, and *Aspidium angulare* f. *grandidens*. The general conclusions of the author are: (1) *Cystopteris fragilis* f. *polyapogama* develops prothallia which show the power of developing sporophytes from unfertilized egg cells or by vegetative apogamy, the two cases sometimes being side by side; (2) the question as to whether *Asplenium germanicum* is a hybrid between two forms is not yet settled, but by crossing *Asplenium septentrionale* (female) and *A. Ruta-muraria* (male), a plant was obtained which stands nearer to *A. germanicum* than any other known form; (3) some fern-forms which had not been investigated before appear apogamous. Of the different forms of *Athyrium Filix-femina* from England, some are true varieties and some revert. Attempts to obtain forkings artificially were unsuccessful.—NORMA E. PFEIFFER.

Water-cultures of fern prothallia.—In a short paper H. FISCHER[20] gives some of his results with the germination of fern spores, in obtaining material for his work on variation, hybridization, etc. He states the advantages of water-cultures over solid substrata as being threefold: the chemical constitution can be regulated; the cultures are cleaner, and material is fit for microtome sections without extra care; the spores may be sowed as thick as desirable, and easily diluted, like a solution, if too close together on germination. The danger lies in the drying out of cultures, or too great evaporation, resulting in plasmolysis. A second danger lies in the production of abnormal forms by too deep layers. The author recommends Pfeffer's nutrient solution and Arthur Meyer's solution, the formula of which he gives. He finds that changing one compound or its concentration, changing the reaction of a solution, etc., often produce the desired germination. But evidently there is no general rule for this, as there is none for the length of time after ripening that a spore will germinate. In *Asplenium Serra*, herbarium material germinated after 48 years. In some few cases the author is as yet unable to induce germination.—NORMA E. PFEIFFER.

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[19] HEILBRONN, ALFRED, Apogamie, Bastardierung, und Erblichkeitsverhältnisse bei einigen Farnen. Flora (n.s.) **1**:1–42. *figs. 43*. 1910.

[20] FISCHER, HUGO, Wasserkulturen von Farnprothallien, mit Bemerkungen über die Bedingungen der Sporenkeimung. Beih. Bot. Centralbl. **27**[1]:54–59. 1911.